

CLAIMS

WHAT IS CLAIMED IS:

1. An optical detection system for use with a surface comprising:
  - a coherent light source for producing a coherent light beam the coherent light beam to generate an illumination spot on the surface, for reflecting an image of the illumination spot; and
  - an optical sensing assembly, having a photosensor array and an optical element, for receiving the image of the illumination spot through each optical element and for generating a speckle image on each photosensor array.
- 10 2. The optical detection system in claim 1, wherein each photosensor array of the plurality of photosensor arrays comprises a plurality of pixels, each pixel is a single photosensitive element for capturing the light intensity of the speckle image.
- 15 3. The optical detection system in claim 1, wherein each photosensor array and each optical element comprises a center, the center of each photosensor array and each optical element aligned with a center of the illumination spot.
4. The optical detection system in claim 3, wherein each speckle image covers at least one pixel.
5. The optical detection system in claim 3, wherein the captured speckle image provides an image data signal.
- 20 6. The optical detection system in claim 1, wherein each optical element of the plurality of optical elements includes an artificially limited aperture.

7. The optical detection system in claim 1, wherein the optical sensing assembly comprises an image motion detection system for detecting movement of the image signal.

5 8. The optical detection system in claim 7, wherein the image motion detection system comprises a cross-correlation module for calculating movement of the image signal relative to an x-direction and a y-direction.

9. The optical detection system in claim 1, wherein each photosensor array of the first and second photosensor arrays is matched with at least one optical element of the first and the second optical elements.

10 10. The optical detection system in claim 9, wherein each photosensor array comprises at least two pixels and each optical element comprises an artificially limited aperture, each artificially limited aperture optically matched to a corresponding photosensor array so that the speckle image average size covers at least one pixel, to generate the unambiguous image signal.

15 11. The optical detection system in claim 10, wherein each artificially limited aperture comprises an anisotropic artificially limited aperture having an aspect ratio, N, where N is the ration of the aperture along a x-direction and a y-direction.

20 12. The optical detection system in claim 11, wherein each photosensor array comprises at least one ( $M \times 1$ ) rectangular shaped pixel, where M is greater than or equal to 2.

13. In an optical detection system housing a coherent light source, a surface, and an optical sensing assembly, a method for detecting movement comprising:

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producing a coherent light beam from the coherent light source to generate an illumination spot on the surface;

diffusely reflecting the illumination spot off of the surface;

5 receiving the diffusely reflected illumination spot at the optical sensing assembly to generate an image of the illumination spot; and

generating an unambiguous image data signal from the image of the illumination spot.

14. A method for detecting movement in claim 13 further comprising optically matching an artificially limited aperture of an optical element of the optical sensing assembly with a pitch of a photosensitive array of the optical sensing assembly to have the image of the illumination spot cover the photosensor array and have a speckle image cover at least one pixel of the photosensor array.

15. A method for detecting movement in claim 13 further comprising applying a cross-correlation function to the generated unambiguous image data signal.

16. In an optical detection system, an optical sensing assembly for generating an unambiguous speckle image data signal from a reflected illumination spot produced from a quasi-collimated beam reflected off of a surface, comprising:

at least one optical element including a lens and an artificially limited aperture for generating a speckle image of the reflected illumination spot;

20 at least one photosensor array, having a plurality of pixels and optically matched with an associated optical element having the artificially limited aperture, for receiving the speckle image to cover at least one pixel to generate an image data signal from the received speckle image.

17. The optical sensing assembly in claim 16, wherein the at least one photosensor array and the associated optical element are configured so that a center of the illumination spot, a center of the lens, a center of the artificially limited aperture, and a center of the photosensor array are aligned on a straight line.

5 18. The optical sensing assembly in claim 17, wherein the at least one photosensor array is mounted on a transparent printed circuit board and the associated optical element is mounted directly opposite of the transparent printed circuit board.

19. The optical sensing assembly in claim 18, wherein the beam shaping optical element is mounted opposite to the transparent printed circuit board.

10 20. The optical sensing assembly in claim 16, wherein each artificially limited aperture is an anisotropic artificially limited aperture having an aperture ratio of N.

15 21. The optical sensing assembly in claim 20, wherein each photosensor array comprises a  $(M \times 1)$  or a  $(1 \times M)$  rectangular shaped pixel array, where M is at least 2 and the aspect ratio of a pixel is N.

22. An optical displacement detection system for comprising:

a coherent light source for emitting a collimated beam;

a surface capable of producing diffusely scattered light and illuminated by the collimated beam for generating a reflected illumination spot;

20 an optical sensing assembly for receiving the reflected illumination spot, the optical sensing assembly having at least one optical element and at least one photosensor array, each optical element including an anisotropic artificially limited aperture for generating a speckle image from the received illumination spot, and each

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photosensor array including a plurality of pixels and an image data signal line, each optical element optically matched with an associated photosensor array for receiving the speckle image to generate an one-dimensional image data signal for the speckle image on each photosensor array; and

5        at least one image motion detection subsystem, each image motion detection subsystem coupled to the image data signal line of a photosensor array, for detecting displacement from the speckle image.

23.      The optical displacement detection system in claim 22, wherein each photosensor array comprises  $(M \times 1)$  pixels or  $(1 \times M)$  pixels, each pixel having an aspect ratio of N.

10        24.     The optical displacement detection system in claim 22, wherein the image motion detection subsystem comprises a cross-correlation module for performing a cross-correlation analysis with the image data signal.

15        25.     The optical displacement detection system in claim 24, wherein the cross-correlation module performs an one-dimensional cross-correlation analysis with the image data signal.

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